MPR 8823.2
REVISION C
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MARSHALL PROCEDURAL REQUIREMENTS

AD01

PRESSURE SYSTEMS CERTIFICATION REQUIREMENTS

DOCUMENT HISTORY LOG

Status (Baseline/ Revision/ Canceled)	Document Revision	Effective Date	Description
Baseline		6/15/00	
Revision	A	7/24/01	Updated applicable documents and references. Revised flex hose testing and safety factor requirements in paragraph A.2.4.
Revision	B	11/21/2003	Page 21, Paragraph A.2.4.6 - Revised flex-hose testing requirements. Added requirement for S&MA to appoint Pressure System Committee member. Added requirement for Pressure System Committee to report status to the Safety, Health and Environmental (SHE) Committee.
Revision	C	10/7/2004	Converted from Marshall Procedures and Guidelines (MPG) to Marshall Procedural Requirements (MPR) document and changed references to MPR and NPR throughout the document. Requirements distinguished by use of the word "shall." Changed font to Times New Roman. Document also reflects minor editorial changes.

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PREFACE

P.1 PURPOSE

The purpose of this document is to define the requirements for certification and operation of pressure systems.

P.2 APPLICABILITY

This document applies to all ground-based, medium-weight, and flight-weight pressure vessels and systems (including vacuum) that are Marshall Space Flight Center (MSFC)-owned or used on MSFC property, in permanent or temporary configurations, regardless of owner or user. The responsible contracting officer shall decide if this Marshall Procedural Requirement (MPR) applies to any offsite contractor that performs work for MSFC and shall make this MPR a contract requirement, if necessary.

P.3 AUTHORITY

NPD 8710.5, "NASA Safety Policy for Pressure Vessels and Pressurized Systems"

P.4 APPLICABLE DOCUMENTS

a. ASME-BPVC8-Div. 1, "Division 1 - Rules for Construction of Pressure Vessels"

b. ASME-BPVC8-Div. 2, "Division 2 - Alternative Rules"

c. ASME-B31.1, "Power Piping"

d. ASME-B31.3, "Process Piping"

e. ANSI/NBBP-NB23, "National Board Inspection Code"

f. ASME-A13.1, "Scheme for the Identification of Piping Systems"

g. Federal Aviation Administration (FAA) Airworthiness Standard, Part 23.54, for Normal, Utility, Acrobatic, and Commuter Aircraft and Part 25.101 for Transport Category Airplanes

h. NPR 1441.1, "NASA Records Retention Schedules"

i. ASTM-MANL-36, "Manual for Safe Use of Oxygen Systems: Guidelines for Oxygen System Design, Materials Selection, Operations, Storage, and Transportation"

j. NSS-1740.16, "Safety Standard for Hydrogen and Hydrogen Systems Guidelines for Hydrogen System Design, Materials Selection, Operations, Storage and Transportation"

k. MPR 8730.5, “Control of Inspection, Measuring, and Test Equipment”

l. MPR 8715.1, “Marshall Safety, Health, and Environmental (SHE) Program”

m. MWI 8715.2, “Lockout/Tagout Program”

n. MWI 8715.15, "Safety Assessment and Risk Mitigation Program”

o. MSFC-HDBK-670, “General Environmental Test Guidelines (GETG) for Protoflight Instruments and Experiments”

p. MPR 8823.1, “Design Control of Facilities”

o. MPR 8040.1, “Configuration Management, MSFC Program/Projects”

P.5 REFERENCES

a. ASME B40.1, “Gauges - Pressure Indicating Dial Type Elastic Element”

b. NASA-STD-5001, “Structural Design and Test Factors of Safety for Space Flight Hardware”

c. NASA-STD-5005, “Ground Support Equipment”

d. 29 CFR Part 1910, “Occupational Safety and Health Standards”

e. 49 CFR, “Transportation”

f. NPR 8715.4, “Inservice Inspection of Ground-Based Pressure Vessels and Systems”

g. MWI 3410.1, “Personnel Certification Program”

P.6 CANCELLATION

MPG 8823.2B dated November 21, 2003

Original signed by
Robin N. Henderson for

David A. King
Director

DOCUMENT CONTENT

1. DEFINITIONS

1.1 Certification. The documented status including cognizant organizational approval signatures that qualifies a pressure vessel or system to operate in the service for which it is intended.

1.2 Maximum Allowable Working Pressure (MAWP). The MAWP for a vessel is the maximum pressure permissible at the top of the vessel in its normal operating position at the operating temperature specified for that pressure.

1.3 Pressure Vessel/System (PV/S). Any pressure vessel and/or system as defined below:

1.3.1 Pressure Vessel - Any container used for the storage or handling of gas or liquid with either internal or external pressure (vacuum vessels are pressure vessels with external pressure). Certification requirements of a particular vessel and its applicability to this document are determined by its class distinction as described below and in paragraph 3.2.

1.3.2 Pressure System - An assembly of components with either internal or external pressure including vessels, piping, tubing, pumps, valves, relief devices, expansion joints, gages, and other related components.

1.3.3 Class I PV/S - Pressure vessels or systems used for test and research investigations or high-risk, low-cost systems. These systems do not meet any national consensus standards or NASA/MSFC specifications/standards. They can be used only if located in an isolated area, buried, or barricaded to preclude injury to personnel or damage to a facility or equipment.

1.3.4 Class II PV/S - Human Flight-Weight - Pressure vessels or systems used in human space flight hardware systems.

1.3.4.1 Associated Aerospace Ground Support Equipment - Pressure vessel or system used and certified (or recertified) to operate in the service for which it is intended by the responsible flight systems or ground support equipment design organization. These vessels and systems normally meet the same consensus standards for ground-based systems except where weight is a factor.

1.3.4.2 Remote-Controlled Flight-Weight - Pressure vessels or systems used in remote-controlled space flight hardware systems or used in ground testing to demonstrate technology for flight systems.

1.3.5 Class III PV/S - Pressure vessels or systems that are primarily ground-based systems for technology applications beyond established detailed national consensus standards. These vessels or systems are designed, developed, and built according to NASA, MSFC, or other Government

agency standards and specifications. They incorporate more analysis and inspection, including hazards analyses, than normally required by national consensus standards.

1.3.6 Class IV PV/S - Industrial pressure vessels and systems that are all ground-based, unfired pressure vessels or systems not covered by Class III. These vessels and systems are designed, developed, and built according to applicable national consensus standards.

1.3.7 Class V PV/S - Pressure vessels and systems that are used in aircraft systems. These are to meet the requirements of FAA Airworthiness Standard, Part 23.54, for normal utility, acrobatic, and commuter aircraft, and Part 25.101 for transport category airplanes.

1.3.8 Class VI PV/S - Pressure vessels and systems that are used for portable or over-the-road-type service.

1.3.9 Class VII PV/S - Pressure vessels and systems that are used for fire protection services. These are designed and built to meet applicable National Fire Protection Association (NFPA) requirements.

1.3.10 Class VIII PV/S - Utility pressure vessels and systems containing air or water meeting the following conditions:

1.3.10.1 Pressure vessels in which pressures are not greater than 863 kPa (125 psig), temperatures are between ambient and 54.4^{o}C (130^{o}F), and pressure times volume is not greater than 981 kPa x m^{3} (5,000 psi x ft.^{3}).

1.3.10.2 Piping and components in which pressures are not greater than 863 kPa (125 psig), temperatures are between ambient and 54.4^{o}C (130^{o}F), and pressure times diameter squared is not greater than 1,422 MPa x cm^{2} (32,000 psi x in.^{2}).

1.3.10.3 Tanks with hydrostatic pressure only located so as to preclude threat to personnel in event of failure.

1.3.10.4 Vacuum vessels and systems less than 2.83 m^{3} (100 ft.^{3}).

1.4 Relief Valve Set Point. The pressure at which a relief device begins to flow. This set point cannot be greater than the MAWP of the lowest pressure-rated component in the system.

1.5 Relief Device Flow Capacity. The rated capacity of a relief device is defined as the flow achieved at 10 percent accumulation in pressure above the set point when vented to atmospheric pressure.

2. RESPONSIBILITIES

2.1 The Center Operations (CO) shall:

2.1.1 Ensure all pressure vessels and systems are designed, fabricated, installed, inspected, tested, certified, operated, and maintained in accordance with NPD 8710.5, MPR 8823.1, and this document.

2.1.2 Appoint a Center Pressure Systems Manager to direct technical efforts and act as the primary point of contact for all technical recertification activities.

2.1.3 Institute in conjunction with the Engineering Directorate and the Safety and Mission Assurance (S&MA) Directorate the formation of a Pressure Systems Committee. This Committee consists of the Pressure Systems Manager and designated representatives of S&MA; Engineering Director's Structures, Mechanics, & Thermal Department; Engineering Director's Materials, Processes, and Manufacturing Department; and the respective user(s), where appropriate.

2.1.4 Maintain current certification records of all active PV/S. Maintain records of inactive PV/S that remain intact as reference data.

2.2 The S&MA Directorate shall:

2.2.1 Ensure that MSFC policy, responsibilities, and requirements for pressure vessels and systems are established and in compliance with this document.

2.2.2 Review and approve, if appropriate, deviations and waivers in accordance with MPR 8715.1.

2.2.3 Establish a training and certification program for operators of pressure systems (see Section 3.3, "Training and Certification").

2.2.4 Establish a PV/S Safety Awareness Program that periodically alerts all MSFC personnel to the proper procedures for working with and around pressure systems.

2.2.5 Appoint a voting member to the Pressure System Committee.

2.3 Users of PV/S shall:

2.3.1 Designate a responsible engineer for each system.

2.3.2 Provide original certification records to the Facilities Engineering Department (FED).

2.3.3 Ensure all personnel operating PV/S are trained and certified in accordance with Section

2.3.4 Correct any certification deficiencies.

2.3.5 Establish and maintain a configuration management system for each PV/S within their interface.

2.3.6 Concur in the determination of interfaces.

2.3.7 Ensure that all PV/S designs, alterations, modifications, and repairs are in accordance with this document.

2.3.8 Describe by detailed engineering documentation the initial design of pressure systems and any subsequent modifications. This engineering documentation shall be submitted to the Center Operations Pressure Systems Manager to ensure all requirements are met.

2.3.9 Ensure that any temporary vessels brought onto MSFC comply with the requirements of this document and S&MA is notified.

2.3.10 Mark and tag all system components properly.

2.4 The Pressure Systems Manager shall:

2.4.1 Approve designs, provide funding forecasts, establish requirements, and provide authority and technical expertise for pressure vessel and pressurized systems in-service inspection and analysis, certification and recertification activities, modifications, and repairs.

2.4.2 Review requests for deviations or waivers of technical requirements as specified in codes and standards and provide analyses and rationale to support the approval of S&MA in accordance with MPR 8715.1 and MPR 8040.1.

2.4.3 Serve as chairman of the Pressure Systems Committee.

2.4.4 Maintain a current inventory and certification status of all ground-based PV/S.

2.4.5 Ensure that PV/S transferred from or to MSFC is properly documented as to the certification status.

2.4.6 Provide and submit the annual NASA Recertification/Certification (RECERT) Status Report to NASA Headquarters.

2.4.7 Ensure that all MSFC offsite facilities such as Michoud Assembly Facility, New Orleans, Louisiana; Assembly Refurbish Facility, KSC, Florida; and Santa Susana Field Laboratory, Canoga Park, California; comply with this directive.

2.5 The Engineering Directorate shall:

2.5.1 Ground-Based PV/S

2.5.1.1 Provide technical and engineering support for ground-based systems when requested by the PV/S users and the pressure systems manager.

2.5.1.2 Provide assistance in accomplishing special analyses, material evaluations, and design verifications. This includes review of proposed waivers and deviations from codes, standards, and guides.

2.5.1.3 Appoint two members to the Pressure Systems Committee. One member from each of the following departments shall be appointed to the committee:

a. Structures, Mechanics, and Thermal Department

b. Materials, Processes, and Manufacturing Department

2.5.2 Flight-Weight PV/S and Associated Ground Support Equipment (GSE)

2.5.2.1 Provide technical review of design, testing, inspection, certification, and recertification of flight-weight PV/S and associated GSE.

2.5.2.2 Ensure that design drawings and related documentation (including inspection and test reports and certification reports) are maintained and updated to reflect current hardware configuration.

2.5.2.3 Approve and ensure that alterations, modifications, or repairs to existing and proposed flight-weight pressurized systems shall be designed, constructed, inspected, tested, and certified in accordance with applicable codes, standards, and guides.

2.5.2.4 Provide plans and schedules to certify and to recertify flight-weight pressure vessels and systems and associated GSE in accordance with this section.

2.6 Program Offices/Managers shall:

2.6.1 Ground-Based PV/S - Ensure this document is made a contractual requirement where deemed necessary and ensure compliance.

2.6.2 Flight-Weight PV/S and Associated GSE

2.6.2.1 Ensure both new and existing pressure vessels and systems for which their organization has responsibility are designed and certified in accordance with program requirements.

2.6.2.2 Ensure the design and development of flight-weight pressure vessels and systems under their cognizance meet all flight safety and operational requirements and that proposed waivers or deviation are properly evaluated and approved.

2.6.2.3 Ensure sufficient design data, operating procedures, system characteristics and constraints, etc. are provided to permit safe conduct of ground test operations without compromising safety of personnel or equipment.

2.7 Pressure Systems Committee shall:

2.7.1 Review recommended requirements and procedures.

2.7.2 Maintain an overview of pressure systems technology.

2.7.3 Participate in recertification activities.

2.7.4 Provide guidance on pressure systems safety to the pressure systems manager and other appropriate officials.

2.7.5 Provide signature approval on Certification Data Packages for all Class I and III PV/S.

2.7.6 Report Pressure System Committee status to the SHE Central Committee.

3. PROCEDURE

3.1 Certification Instructions and Requirements: Certifiers of pressure systems shall:

3.1.1 Identify the PV/S.

3.1.2 Determine the appropriate class.

3.1.3 Determine the certification criteria for the class.

3.1.4 Determine the “as-built” design and fabrication requirements for the PV/S.

3.1.5 Conduct a design analysis of the PV/S.

3.1.6 Perform a physical inspection of the PV/S.

3.1.7 Identify and remove any hazards or potential risks involved with the PV/S.

3.1.8 Determine any modification, repair, testing, or other work that shall be accomplished prior to or as a condition of certification. Document and track this effort to ensure accomplishment.

3.1.9 Develop safe operating rationale based upon the above steps considering the status of any modification, repair, or tests required.

3.1.10 Generate a Certification Data Package that documents the results of all the above. Provide a record copy of the Certification Data Package to FED and a working file copy in a central user location.

3.1.11 Generate a certificate similar to that listed in Section 4 and submit the certificate, along with the Certification Data Package, to S&MA and Center Operations Pressure Systems Manager for approval. Prior to submittal, certificates for all PV/S that are categorized as Classes I and III shall be reviewed and bear the concurrence signatures of the Pressure Systems Committee. All certificates are signed by the respective user prior to submittal for approval.

3.1.12 Establish recertification procedures for all PV/S based upon these instructions.

3.2 Notes

3.2.1 Class I - These PV/Ss shall be analyzed on a case-by-case basis by stress and materials disciplines to verify the safety factor considering all aspects of their design usage, extenuating operational factors, and degree of isolation. These vessels shall pass an Operational Readiness Inspection (ORI) or safety review conducted in accordance with MWI 8715.15, "Safety Assessment and Risk Mitigation Program," or a waiver of this requirement shall be approved by the pressure systems manager with the concurrence of S&MA.

3.2.2 Class II - These PV/Ss shall be analyzed by stress and materials disciplines. Criteria for certification of these vessels and systems and associated aerospace GSE shall be developed for the respective project commensurate with all flight and ground safety and operational requirements. Proof testing is in accordance with MSFC-HDBK-670. These criteria and subsequent certification efforts shall be applied through the respective program or project channels and shall be excluded from further reporting requirements of this directive. Certifications and waivers or deviations for these systems shall be approved by the program or project manager with the concurrence of S&MA.

3.2.3 Class III - PV/S of this class shall have appropriate stress and material analyses to ensure that safety factors are equal to or exceed the requirements of the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1 or 2. Allowable stresses shall be governed by the appropriate tables or appendices of either Division 1 or 2 of the Code. If the vessel evaluation is based on Division 2, a fatigue analysis shall be required. Certification of other system components (piping, tubing, valves, fittings, etc.) shall be based on meeting the intent of the ASME Codes for Pressure Piping, B31.1 or B31.3, as determined by engineering evaluations and appropriate engineering rationale.

3.2.4 Class IV - Certification of PV/S shall be based upon the fact they are code stamped to ASME standards and the code status has not been nullified by vessel modification or repair.

Certification of the remainder of the system (piping, valves, regulators, fittings, etc.) shall be based upon evidence of compliance with ASME and the American National Standards Institute (ANSI) standards.

3.2.5 Class V - Certification of these PV/Ss shall be controlled by the FAA and is excluded from further requirements and reporting specified by this directive.

3.2.6 Class VI - Certification of PV/S shall be controlled by Department of Transportation requirements as specified in CFR, Title 49. When utilized for over-the-road hauling on public highways, these pressure vessels and systems are excluded from further requirements and reporting specified by this directive. When they are used exclusively for local (on-post) hauling or portable storage, these vessels and systems shall be certified as specified for Class III or IV above, including appropriate stress and material analysis.

3.2.7 Class VII - These PV/Ss shall be to be certified as specified by the NFPA requirements and are excluded from further requirements and reporting specified by this directive.

3.2.8 Class VIII - These PV/Ss shall be excluded from the scope of this directive.

3.3 Personnel Training and Certification:

Personnel training and certification shall be in accordance with MWI 3410.1, "Personnel Certification."

4. RECORDS

4.1 Certification Form - MSFC Form 4311, "Pressure Vessel or System Certification," and associated data package shall be maintained by AD24 for the life of the PV/S and destroyed 25 years after PV/S ceases to exist as noted in accordance with NPR 1441.1, "NASA Records Retention Schedules."

(Typical Record)
Data Package Index
Multilayer Pressure Vessel
15,000 PSIG - 100 FT^3
C.B.&I. Co. Contract 9-1968
Vessel No. M208

Responsible Engineer/Organization:

I. MANUFACTURERS' DATA

1. Manufacturer Data Report
2. Fabrication Drawings, 9-1968

3. Name Plate Facsimile
4. Hydrostatic Test
5. Certification of Cleanliness
6. Pressure Certification
7. Analysis Report

II. HISTORY

1. Narrative

2. Hydrostatic test specification, pages 15C-9, 10, Division 15, Section 15C, MSFC Spec. No. F&D-544, Project 6236, Construction Specification for Addition to GSE Test Facility (attachment).

3. Hydrostatic Test Specification, Par 5.a.5, page 15G-2, Section 15G, MSFC No. DAC 87-73-B-9003, Specification for Modification of Acoustic Model Engine Test Facility at MSFC (attachment).

4. Installation Drawings

   a. Addition to GSE Facility High-Pressure Fluid Test Cell, F&D-A-S4648 M1, M4, M7.
   b. Piping and Elevation, GH2 Storage Bottles Test Stand 116, FAC-A-4540 M 24.
   c. Photographs of 10,000 psi GH_2 Storage Vessel Installation.

5. Cycle History

6. Proximity Data

5. FLOW DIAGRAM

None

APPENDIX A

CERTIFICATION CRITERIA

A.1 General - Activity involving pressure systems that are not certified according to any of the criteria given in this document shall be subject to personnel access restrictions as stated below:

A.1.1 Personnel engaged in the operations of pressure systems shall be qualified through training and experience in accordance with Section 3.3 of this directive.

A.1.2 Personnel access for Class I and Class II pressure systems shall be requested from S&MA on a case-by-case basis. These systems shall be operated remotely in areas designed for pressure testing to minimize the risk to personnel, property, and equipment.

A.1.3 Determination of siting restrictions for Class I and II systems shall be requested from S&MA on a case-by-case basis.

A.1.4 Personnel access, siting restrictions, or other protective features shall be based on quantitative and qualitative analysis which:

A.1.4.1 Assumes failure of the system at a worst-case maximum pressure/temperature condition.

A.1.4.2 Estimates fragmentation and over-pressure effects (catastrophic or leak-before-burst failure mode shall be determined).

A.1.4.3 Assesses the potential for secondary effects such as fire, explosion, motion of failed components, high-velocity gases, noise, and asphyxiant gas release.

A.1.5 Any deviations from the requirements of this standard shall be reviewed and approved by S&MA. Approval shall be based on the demonstrated presence of compensating features which provide equivalent safety of personnel and property.

A.2 Class III and IV PV/S – Installation Requirements

NOTE: The following requirements apply to all Class III and IV systems. Other class systems may utilize these as guidelines if appropriate for the application.

A.2.1 General Criteria

A.2.1.1 Pressure systems shall conform to ASME B31.1, ASME B31.3, or the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1 or 2, as applicable, except as noted under criteria for Class III vessels. The rules of the NBIC (ANSI-NB-23) shall be used for the repair and alteration of in-service, pressure-retaining items. When one of these codes is chosen, the

requirement shall be met in its entirety.

A.2.1.2 All systems shall be designed and assembled in such a manner that external pressurization sources and internal fluid sources can be isolated quickly and positively in an emergency.

A.2.1.3 Provisions shall be made for depressurizing all elements of pressure systems to zero kPa (psig) by use of an appropriate vent valve. Small components such as gages requiring periodic removal or isolation from the system for calibration or service shall be provided with an isolation valve to vent the component without the necessity of venting the entire system.

A.2.1.4 To facilitate effective cleaning of large, fixed-pressure vessels, low-point drains shall be provided when cleaning is required during installation or after repair.

A.2.1.5 Adequate clearance around pressure vessels shall be provided for maintenance and inspection. Clearance between the vessel and floor shall be provided to minimize corrosion from moisture.

A.2.1.6 As a minimum, pressure measuring devices shall be installed at the system interface with its source pressure and downstream of all pressure-reducing valves.

A.2.1.7 Systems shall be provided with adequate pressure measuring devices. The normal operating ranges of dial-indicating pressure gages in fixed systems shall be between 25 and 75 percent of full-gage scale so that the system MAWP falls within the middle half of the scale.

A.2.1.8 System measuring devices shall be classified and calibrated in accordance with MPR 8730.5. Items classified for “reference only” shall have an established procedure to ensure proper function for the intended usage.

A.2.1.9 Temperature-measuring devices shall have thermowells, where appropriate, rated at the system pressure relief device set point.

A.2.1.10 Relief valves shall be verified at least every 5 years.

A.2.1.11 Relief device outlets shall be designed and installed in such a manner as to prevent accumulation of water and subsequent freezing or corrosion and to prevent blockage by insect or bird nests.

A.2.1.12 Pressure-system piping shall be legibly marked, identifying contents, temperature, pressure, and flow direction in accordance with ASME A13.1.

A.2.1.13 Downstream relief features built into pressure regulators shall be allowed in lieu of separate relief devices if it can be demonstrated that the relief features comply with all other requirements of this directive.

A.2.2 Flammable, Toxic, and Asphyxiant Fluid Systems

A.2.2.1 All vents from systems using flammable or toxic (including oxygen) fluids shall be vented to safe areas outside of occupied buildings. This includes the discharge of internal relief regulators, relief valves, manual vents, and any other fluid system component.

A.2.2.2 All blow-down vents from systems using asphyxiant fluids shall be vented to safe areas outside of occupied buildings. This includes the discharge of relief valves.

A.2.2.3 If flammable or toxic fluids are to be used within an occupied building (even if properly vented), and the potential exists for the oxygen level to be depleted below 19 percent, the building or user shall have an appropriate monitor to detect the presence of the fluids. The detector shall detect the fluid in the atmosphere at levels below those where concentrations would become harmful or unsafe.

A.2.2.4 Electrical components in flammable fluid systems shall meet or exceed the NFPA requirements.

A.2.2.5 Oxygen-deficiency monitors shall be utilized in occupied buildings where simple asphyxiant fluids are used.

A.2.2.6 Hydrogen systems shall meet the requirements of NASA-STD 8719.16. Oxygen systems shall meet the requirements of NASA-STD 8719.15.

A.2.3 Pressure System Panels

A.2.3.1 All panels shall have an isolation valve.

A.2.3.2 All inspection plugs, pressure gages, temperature gages, and safety relief valves shall be readily accessible for service and inspection.

A.2.3.3 Panels fed from portable sources (i.e., trailers, K-bottles) shall have supply-hose anchors.

A.2.4 Flexible Pneumatic and Cryogenic Hoses

NOTE: This section applies to hoses that are used in pneumatic systems over 1034 kPa (150 PSIG) and all cryogenic hoses. The following are excluded from the requirements of this section:

- *Hydraulic hoses*
- *Metal bellows*
- *Pneumatic hoses being used at 1034 kPa (150 psig) or less*

A.2.4.1 Flexible hoses shall not be installed in lieu of rigid piping or tubing. Flexible hoses shall only be used for vibration isolation, component flexibility, connections to offload from a temporary container, or other temporary applications where the use of rigid piping or tubing is impractical.

A.2.4.2 Flexible hoses shall be protected from personnel traffic and moving equipment damage.

A.2.4.3 Flexible hoses shall be inspected before each use. A hose that leaks or has flat areas, kinks, sharp ends, twists, damaged fittings, overdue pressure tests, or excessive corrosion or deterioration shall be removed from service and replaced with a new hose. Defective hoses shall be destroyed.

A.2.4.4 Flexible hoses shall be marked to indicate MAWP and date of last pressure test. Flexible metal hoses for which the working pressure is unknown or cannot be established shall be destroyed.

A.2.4.5 Flexible hoses shall not be subjected to pressures greater than the MAWP. The safety factor for flexible hoses in occupied areas shall be a minimum of 4:1, based on burst, for hoses less than or equal to ½" in diameter. Hoses greater than ½" in diameter shall have a minimum safety factor of 3:1, based on burst.

A.2.4.6 Specific requirements for pneumatic hoses

a. Flexible pneumatic hoses shall be restrained at the hose end connector and/or each union or hose splice. The most effective restraints are Kellum®-type devices. Other restraints such as clamps, brackets, steel cables, fabric webbing, steel chains, or other devices may also be used. Sandbags or concrete blocks shall not be permitted.

b. The flexible pneumatic hose restraint shall be attached to a substantial object using a clevis when in use.

c. Flexible pneumatic hoses shall be hydrostatically tested to 150 percent of the MAWP (or pneumatically tested to 120 percent of the MAWP if it is necessary to maintain cleanliness) with a leak-check at MAWP prior to initial use and after each year of service. Hoses for service above 4000 psi shall be pressure tested to 200 percent of rated pressure at the factory and shall have a 4:1 safety factor based on burst pressure. Flexible hoses installed for vibration isolation, thermal expansion/contraction, rubber hoses used at 150 psig or less, or hoses that are infrequently disconnected are excluded from the annual testing requirement.

A.2.4.7 Specific requirements for cryogenic hoses

Flexible cryogenic hoses shall be hydrostatically tested to 150 percent of the MAWP (or pneumatically tested to 120 percent of the MAWP if it is necessary to maintain cleanliness) prior to initial use and after every 5 years of service except that hoses in liquid oxygen service shall be

tested after every 2 years of service.

A.3 Test and Inspection

A.3.1 Pressure systems shall be inspected and tested in accordance with the applicable code(s).

A.3.2 Components shall be pressure tested prior to use. This can include testing performed by the manufacturer for new components.

A.3.3 Systems or components that are modified, repaired, or suspected of damage shall be pressure tested in accordance with the governing code prior to operation.

A.3.4 Open-end systems such as vent lines shall be exempt from the above pressure test requirements unless any of the following are true:

A.3.4.1 The maximum pressure in the line under flowing conditions can exceed 50 percent of MAWP.

A.3.4.2 The fluid in the line is flammable, explosive, or toxic.

A.3.4.3 The line is subject to significant dynamic load.

A.3.5 Personnel shall be cleared from the area while performing pressure tests above MAWP, and measures are to be taken to prevent nonessential personnel from entering the area.

A.3.6 Adequate venting shall be provided at high points of vessels to prevent collapsing during draining of liquids.

A.4 Safety Notes

A.4.1 Repairs or modifications performed on high-pressure fluid systems or components shall be done in accordance with approved work orders.

A.4.2 Personnel shall be protected from energy sources when performing maintenance and repairs by implementing lockout/tagout procedures in accordance with MWI 8715.2, “Lockout/Tagout Program.”

A.4.3 PV/S shall be considered potentially hazardous until it is established that the system is at ambient pressure. Prior to disconnecting any portion of a pressure system, personnel shall ensure the system has been depressurized.

A.4.4 Entrances to all areas where high-pressure operations are performed or areas of high-pressure gas storage shall be posted with warning signs. All work areas where high-pressure operations are performed shall be strictly controlled. Entrance to high-pressure operation areas

shall be restricted to authorized personnel only.

A.4.5 Test and storage areas where leakage can present a toxic or flammable hazard to personnel or equipment shall be equipped with gas detectors and audible alarms.

A.4.6 Personnel operating pressure systems shall wear face shields, goggles, or safety glasses with side shields. Additional personal protective equipment may be required depending on other hazards present.

A.4.7 Pressure system operations shall be conducted using written procedures conforming to MWI 8715.15, “Safety Assessment and Risk Mitigation Program,” and shall be reviewed and approved by S&MA.

APPENDIX B

SUPPORTING CRITERIA FOR CLASS III AND IV PV/S

Note: The following statements fall within the requirements of the consensus codes identified in Appendix A. They are listed below in order to prevent design oversights that have historically occurred and to emphasize the necessity of including these factors in system designs. This should in no way be considered a complete checklist for designers since all systems must be constructed in total compliance with the applicable PV/S code.

B.1 Overpressure protection devices shall be installed downstream of pressure regulators unless the downstream system is designed for the maximum pressure upstream of the regulator (ASME B31.1, paragraph 122.5).

B.2 Discharges from vents, relief devices, and gage blowout ports shall be located or directed away from personnel and equipment (ASME B31.1, paragraph 122.6.2).

B.3 Piping and fitting materials shall be compatible with the media. Fasteners shall be compatible with the joint material. Where dissimilar materials are being joined, fasteners that minimize corrosion shall be selected. If needed, the Engineering Directorate shall assist in the selection of materials (ASME B31.1, section 123).

B.4 Supplier's catalog pressure ratings for piping and tubing shall not take precedent over applicable code requirements. Maximum pressure ratings for piping and tubing shall be based on the allowable stresses listed in the applicable piping code (ASME B31.1, paragraph 102.2).

B.5 All components within a system shall have an MAWP equal to or greater than the set pressure of the relief devices protecting the component (ASME B31.1, paragraph 122.5).

B.6 Each component of a pressure system shall be legibly marked (to the extent practical) to indicate the part number, manufacturer, maximum working pressure, and temperature (ASME B31.1, paragraph 107.2).

B.7 Dial-indicating test gages used for pressure testing components above the MAWP shall have a range of not less than 1.5 nor more than four times the test pressure. Digital-reading pressure gages having a wider range of pressure may be used provided the readings give the same or greater degree of accuracy as obtained with dial pressure gages (ASME BPVC, Section VIII Division 1, paragraph UG-102).

B.8 Downstream overpressure protection shall be sized on the assumption that the upstream pressure source is flowing at its maximum opening with an inlet pressure equal to the set pressure of the upstream relief device (ASME BPVC, Section VIII, Division 1, paragraph UG-133).

B.9 Downstream relief devices shall be installed as close as possible to the outlet of the pressure source (ASME B31.1, paragraph 122.5.1).

B.10 Burst or rupture disks shall be allowed in lieu of, or in conjunction with, other mechanical devices. However, due to the nature of these devices, they do not require 5-year verification. These devices are susceptible to fatigue failures and shall be replaced per the manufacturer's recommendations (ASME BPVC, Section VIII, Division 1, paragraph UG-127).

B.11 Pressure vessels and systems protected by a single relief device shall be designed to ensure that pressures do not rise more than 10 percent above the MAWP and their settings do not exceed the MAWP (ASME BPVC, Section VIII, Division 1, paragraph UG-125).

B.12 Pressure vessels and systems with multiple relief devices shall be designed to ensure that pressures do not rise more than 16 percent above the MAWP. The primary device setting shall not exceed the MAWP, and the secondary device setting shall not exceed 105 percent of the MAWP (ASME BPVC, Section VIII, Division 1, paragraph UG-125).

B.13 Pressure-reducing valves and similar mechanical or electrical control instruments, except for pilot-operated valves, shall not be considered sufficiently positive in action to prevent excess pressures from being developed (ASME BPVC, Section VIII, Division 1, paragraph UG-126).

B.14 Relief devices shall be properly supported to withstand reaction loads at their rated flow and pressure (ASME B31.1, paragraph 122.6).